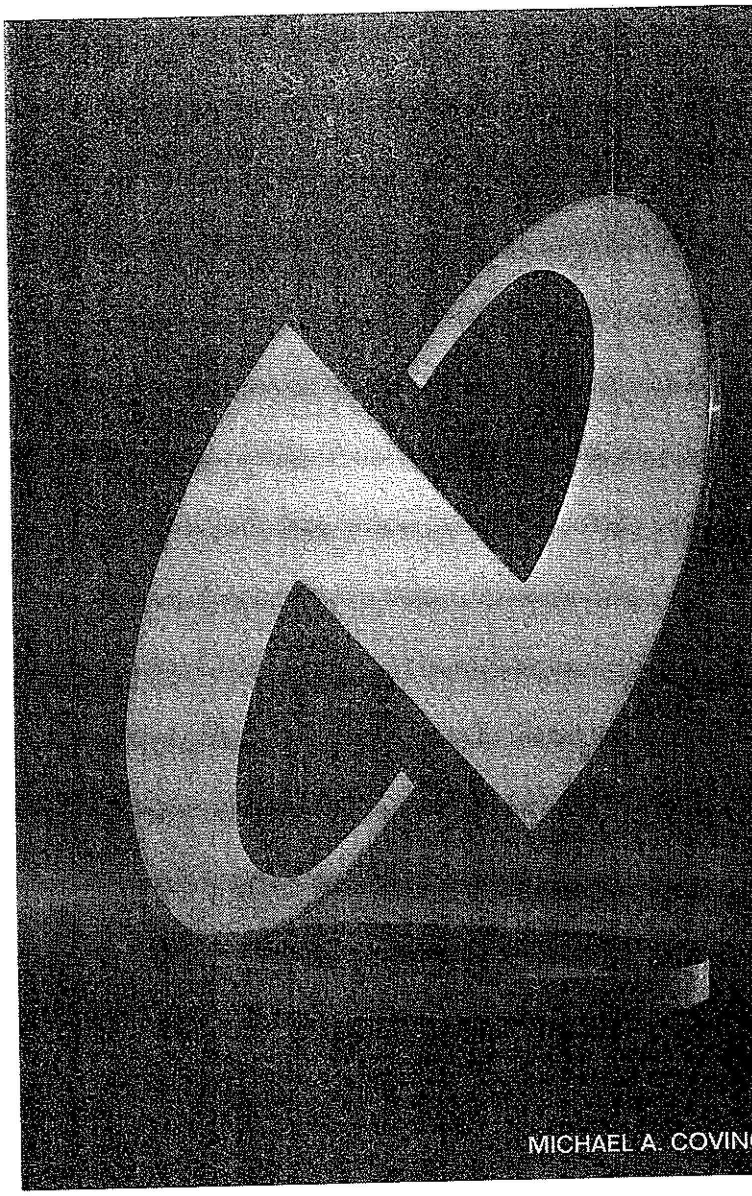


Audio Gets Easier

Using the New LM4862

MICHAEL A. COVINGTON

This new "Boomer" audio amp from National Semiconductor is easier to use, offers better performance, and needs fewer bulky external components than anything previously available.

Any electronic device that makes sound in a speaker—at least if the sound is more than digital beeps—needs an audio amplifier. Until now, the most popular IC for driving small speakers has been the LM386, introduced in 1975 by National Semiconductor. Figure 1 shows a typical circuit. Compared to the discrete-component circuits that preceded it, the LM386 was a godsend; it could deliver 0.2 watt into an 8-ohm speaker from a 9-volt supply without an output transformer.

But the LM386 wasn't perfect. As Fig. 1 shows, it requires large electrolytic capacitors, which add bulk and cost to the circuit and can distort the sound as they age. Further, the input impedance of the LM386 is very high, making it prone to oscillation if the inputs aren't carefully separated from the outputs. Its voltage gain of 20 (or 200 with one capacitor added) is a bit too high for line-level input (1V RMS) and contributes to the oscillation problem.

Twenty years went by, and National Semiconductor has recently introduced a new line of easy-to-use "Boomer" audio amplifiers. The handiest of these is the LM4862, which is available in both surface-mount and DIP packages with the same pinout (LM4862M and LM4862N respectively). It can deliver 0.675 watt into an 8-ohm speaker at 1% total harmonic distortion. (At slightly lower power levels, distortion is appreciably less.) What's more, it has automatic thermal shutdown to protect it from damage if overloaded, and it operates from a single 5-volt supply. The input impedance is relatively low and user settable, so the risk of oscillation is much lower.

Inside the Chip. Figure 2 shows what's inside the device. The LM4862 drives the speaker differentially, applying opposite waveforms to the two terminals—a configura-

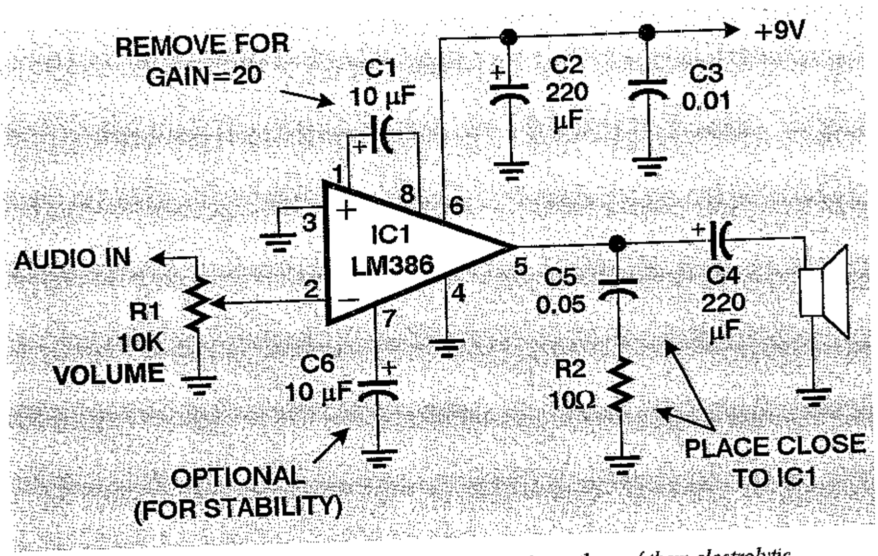


Fig. 1. The classic LM386 audio amplifier needs six capacitors, three of them electrolytic.

tion often called BTL (bridge-tied load) Either side of the speaker can go to +5V, while the other side goes to 0V. Thus, the amplifier can produce 10 volts of swing from a 5-volt supply That's enough for room-filling volume with a 4-inch full-range speaker

The supply voltage can range from 2.7 to 5.5 volts; naturally, the amplifier can deliver more power if the supply voltage is near the high end of the range You can power the LM4862 from two or three 1.5-volt cells or a regulated 5-volt supply (Do not use a 6-volt battery; it exceeds the maximum rating.) Total current consumption ranges from 5 mA when quiet to about 250 mA at maximum volume. Power-supply ripple rejection is excellent, better than 50 dB when C2 = 1 µF

Using the Chip. A typical amplifier circuit is shown in Fig 3. It's simple and does not require electrolytic capacitors; that keeps the cost down and ensures high-fidelity audio Actually, C2, the bias bypass

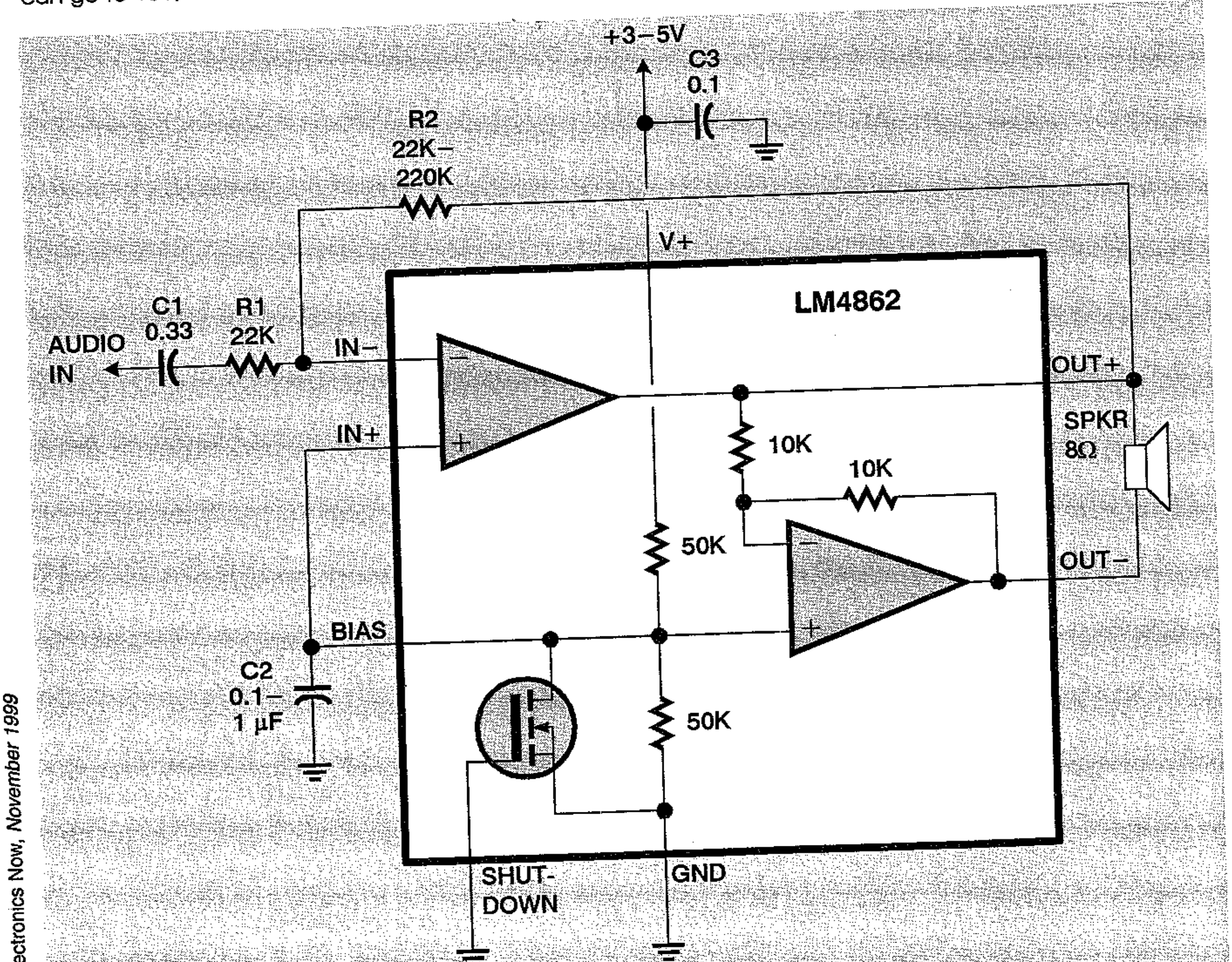


Fig. 2. The new LM4862 needs fewer external components and is less prone to oscillation than the LM386.

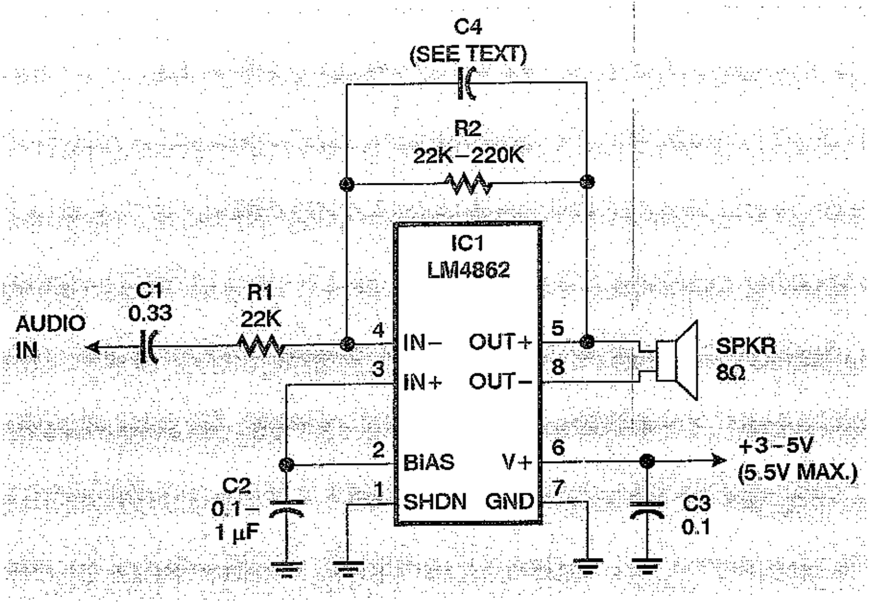


Fig. 3. A typical circuit using the LM4862. Place C3 as close to the IC as possible.

capacitor, can be a tantalum electrolytic; the audio signal doesn't pass through it. Also, a 100-µF electrolytic in parallel with C3 is a good idea when using batteries or a poorly regulated power supply.

The voltage gain is equal to 2(R2/R1) and should not exceed

	HIGH FIDELITY (20–20,000 Hz)	POWER SAVING (150–20,000 Hz)
LOW GAIN ($A_V = 2$)	R1 = 22K R2 = 22K C1 = 0.33 C2 = 1.0 µF C4 OMITTED	R1 = 22K R2 = 22K C1 = 0.05 C2 = 0.1 µF C4 OMITTED
HIGH GAIN ($A_V = 20$)	R1 = 22K R2 = 220K C1 = 0.33 C2 = 1.0 µF C4 = 22 pF	R1 = 22K R2 = 220K C1 = 0.05 C2 = 1.0 µF C4 = 22 pF

Fig. 4. Here are some component values for variations of the circuit in Fig. 3.

20; sound quality is best when R2 = R1 and the gain is 2. (That's exactly what you need to drive a speaker from 1-volt line-level or headphone-level audio.) When the gain is higher than about 5, R2 should be bypassed by a small capacitor (C4) to prevent oscillation. A 5-pF capacitor will do the job, but a 22-pF capacitor will probably be easier to find; do not use values larger than 32 pF. If the input signal is coming from a low-impedance source, you can use smaller resistors, such

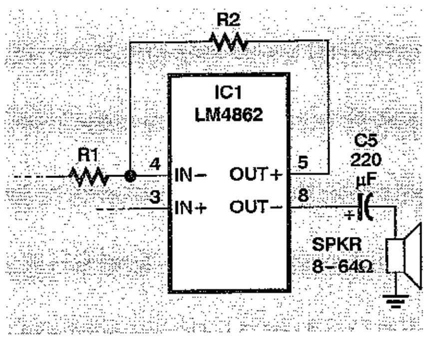


Fig. 5. How to drive a grounded circuit. The balance of the circuit is shown in Fig. 3.

as R1 = 4.7K and R2 = 4.7K to 47K.

Figure 4 gives component values for some typical amplifiers. Note in particular that you can save battery power, as well as component cost, by cutting the bass response when driving a small speaker that wouldn't reproduce low frequencies anyhow.

The speaker impedance must be at least 8 ohms. You can use a 16-, 32-, or 64-ohm speaker, but you'll get considerably less power out. If you must ground one side of the speaker, drive the other side through a capacitor as shown in Fig. 5; you'll get only a quarter as much power as if the speaker were driven differentially.

The shutdown (SHDN) pin disables the amplifier, bringing both outputs low and cutting power consumption to less than 1 micro-ampere (yes, microampere), when connected to +5V. The shutdown pin is grounded in normal use. You can use it to implement a "mute" button without putting a switch in the signal path, or even wire it to a headphone jack to silence the speaker when headphones are plugged in.

The bias pin is the output of a voltage divider built into the chip. Its purpose is to hold the positive inputs of both op-amps at half the supply voltage so that they can operate with a single supply. You can also use the bias pin to bias one or two additional op-amps as shown in Fig. 6.

The bias pin should be bypassed to ground by a capacitor between 0.1 and 1.0 µF. Larger values improve ripple rejection and suppress the "thump" when the amplifier is turned on.

Some Applications. The LM4862 teams up well with other low-voltage ICs. For example, Fig. 7 shows an experimental AM radio based on the Plessey (formerly Ferranti) ZN414 TRF receiver chip. On the breadboard, this circuit gave high-fidelity

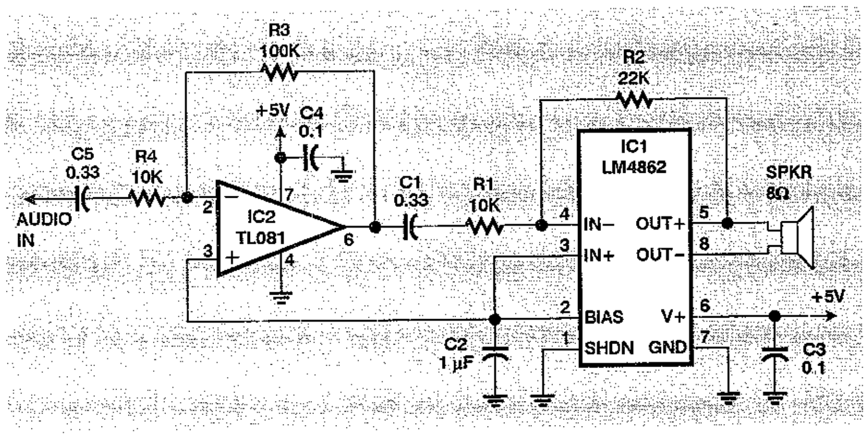


Fig. 6. You can use the bias pin, pin 2, to bias one or two external op-amps as shown here.

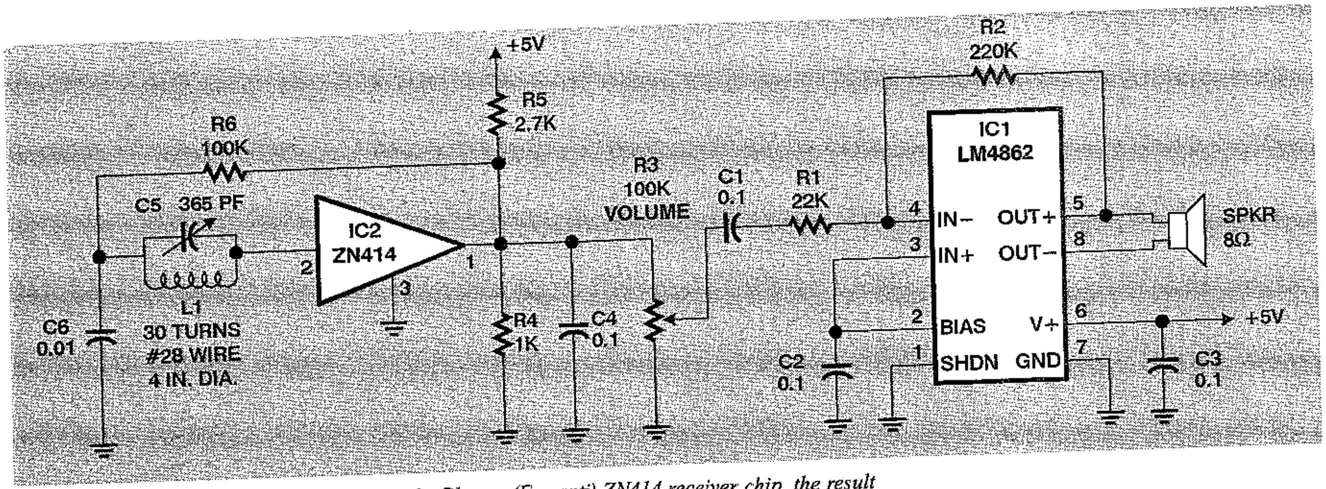


Fig. 7. When the LM4862 is combined with the Plessey (Ferranti) ZN414 receiver chip, the result is a simple, high-quality AM receiver.

reception of local AM stations.

Like other amplifiers, the LM4862 makes a fine oscillator. Figure 8 shows a classic op-amp square-

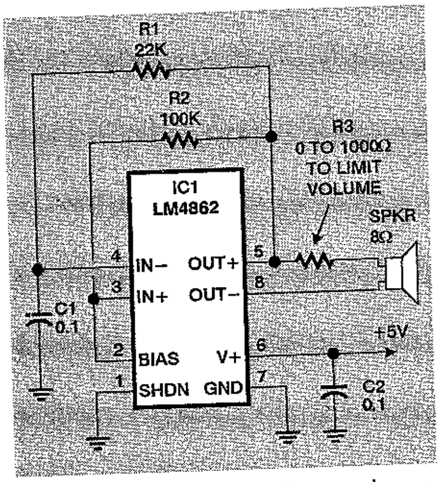


Fig. 8. This squarewave oscillator produces a loud 1-kHz tone in the speaker.

wave oscillator that can serve as a loud siren—at least twice as loud as any conventional 5-volt circuit.

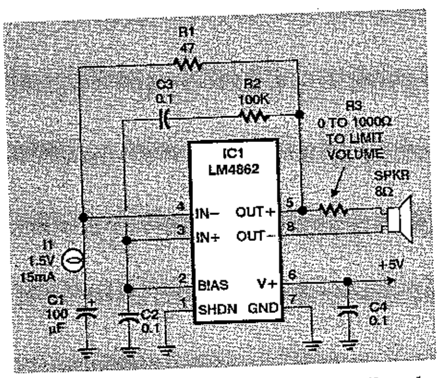


Fig. 9. A tiny "grain-of-wheat" light bulb is the feedback regulator in this circuit for a Wien-bridge oscillator.

Figure 9 shows a Wien bridge that produces a low-distortion sine wave.

In the last circuit, a 1.5-volt, 15-mA light bulb (RadioShack 272-1139)

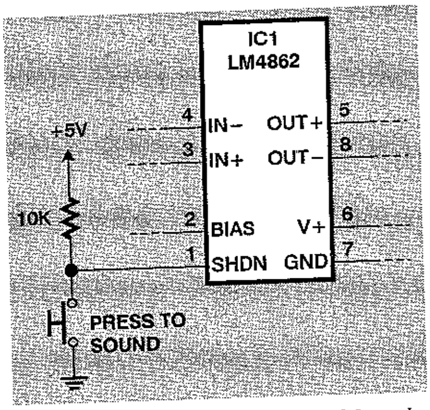
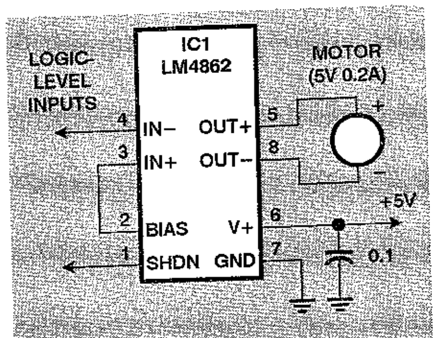


Fig. 10. The oscillators in Figs. 8 and 9 can be pushbutton controlled as shown here.

serves as the regulating element in the feedback loop. As current increases, the bulb heats up and its resistance increases, cutting feedback and stabilizing the oscillator. The bulb does not actually glow visibly in normal operation. Resistor R1 is closely matched to the bulb and will require a different value if a different kind of bulb is used.

To make either of the oscillators sound at the press of a button or to use them for Morse code practice, add a momentary-contact switch that grounds the shutdown pin as shown in Fig. 10. The 10K resistor is needed because the shutdown pin has no internal pull-up; if unconnected, it "floats" to a random voltage and the LM4862 operates very erratically.

Finally, a speaker isn't the only



INPUTS		MOTOR ACTION
SHDN	IN−	
+5V	ANY	STOP
0V	0V	RUN FORWARD
0V	+5V	RUN BACKWARD

Fig. 11. Using the LM4862 as a bi-directional motor controller.

thing the LM4862 can drive differentially. It also makes a fine full-bridge bi-directional driver for small motors. Figure 11 shows a circuit that was breadboard-tested with a 6-volt tape-recorder motor (running on 5 volts, of course). In this circuit, the inputs of the LM4862 are compatible with CMOS logic outputs, making computer control easy to implement.

Availability. One potential problem with the chip for hobbyists is that it is not that widely available. National does provide free samples to engineers and sometimes others. For more information, see their Web site at www.national.com. It is also available from traditional full-line distributors such as Newark Electronics (www.newark.com). Ω